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APPLICATION OF MICRO-ELECTRONIC TECHNOLOGY TO ASSIST ELDERLY AND DISABLED TRAVELLERS

BY

Jouko A Parviainen
PARVIAINEN & ASSOCIATES

- IN CO-OPERATION WITH -

Wally G Atkinson
MANOP SERVICES LTD

Margaret L Young
THE HUGH MACMILLAN REHABILITATION CENTRE

FOR

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Jouko A Parviainen, with Wally G Atkinson (Manop Services Ltd) and Margaret L Young (The Hugh MacMillan Rehabilitation Centre)

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9. Performing Organization Name and Address

Parviainen & Associates
1125 Linbrook Road
Oakville, Ontario, Canada L6J 2L3
Tel: 416-849-5806 Fax: 416-844-9945

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16. Abstract

The report presents an exploratory investigation into micro-electronic hardware and software technologies that can best be adapted for both personal usage and usage on-board road vehicles to assist elderly and disabled travellers. It identifies those system functions and features which have the potential to improve mobility, increase personal safety and security, and make travelling more predictable and enjoyable.

The potential features are categorized into seven functional areas: travel advisory and navigation; specialized transportation advisory; vehicle monitoring, safety and performance; vehicle control; driver monitoring and assist; primary driving controls; and secondary driving controls. The report further documents specific application packages ranging from simple accessible entrance locators, to enhanced night vision systems, and driver monitoring and advisory systems.

It is recognized that a significant research, development and demonstration effort is required to accelerate the availability of these systems. Four priority project areas are recommended to form the core of research in the application of Intelligent Vehicle Highway Systems/Road Transport Informatics technologies to assist elderly and disabled travellers. These cover human factors/ergonomics research, advanced traveller information systems (ATIS/E&D), advanced vehicle control systems (AVCS/E&D), and research on traveller decision making.

The implementation of these systems can be expected to significantly contribute to enabling persons with physical, cognitive, mental and other disabilities - as well as elderly people in general - to lead more productive and satisfying lives through increased mobility and self-sufficiency. It is essential, however, that E&D needs are recognized now, early in the development of the mobile information systems and in-vehicle devices - and not just as an afterthought, which would surely result in cumbersome, user-unfriendly retrofits. Indeed, there are sound economic and business reasons to recognize E&D requirements now, as it will significantly enhance the marketability of the devices to the users-at-large.

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Parviainen & Associates
1125 Linbrook Road
Oakville (Ontario)
L5J 2L3

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Complexe Guy-Favreau
200 ouest, boul. René-Lévesque
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16. Résumé

Ce rapport rend compte de la recherche exploratoire sur les applications de la micro-électronique en transports et sur les aides électroniques portatives et embarquées qui permettront aux personnes âgées ou handicapées à se déplacer plus facilement. Il met en évidence les fonctionnalités et les caractéristiques à mettre en oeuvre, dans le but d'accroître la mobilité, renforcer la sûreté et la sécurité et redonner le goût de se déplacer.

Ces fonctionnalités et caractéristiques devront relever de l'un des sept secteurs fonctionnels suivants : systèmes d'information et aides à la navigation; systèmes d'information dédiés aux transports; systèmes de suivi de la sûreté et des performances du véhicule; aides à la conduite de véhicules; aides à la vérification et à l'entretien des véhicules; systèmes de commande principaux et systèmes secondaires de commande. Le rapport décrit quelques applications spécifiques, allant de la localisation des entrées accessibles aux dispositifs de vision nocturne améliorés, en passant par les aides à la conduite (suivi de l'état du conducteur) et l'information routière embarquée.

Le rapport souligne la nécessité d'un ambitieux programme de R&D sur les applications de la micro-électronique aux transports visant à hâter leur développement. Quatre axes de recherche sont proposés, à être entrepris en priorité dans le cadre du programme de R&D sur les systèmes routiers intelligents et visant à accroître la mobilité des personnes âgées ou handicapées. Ces quatre axes sont : les facteurs ergonomiques, les systèmes avancés d'information routière embarquée, les aides à la conduite de technologie avancée et les aides à la prise de décision en matière de déplacements.

Il est fort possible que la mise en oeuvre des technologies fondées sur la micro-électronique parvienne à améliorer grandement le sort des personnes ayant une incapacité physique, sensorielle, cognitive, mentale ou autre, ainsi que celui des personnes âgées, et qu'elle leur permette de mener une vie plus productive et agréable, grâce à une mobilité et une autonomie accrues, dans le confort et la sécurité. Mais il faut savoir que la prise en compte des besoins des personnes âgées ou handicapées doit intervenir tôt dans le processus de développement de toutes ces aides, embarquées ou non, pour ne pas risquer de faire de celles-ci de simples ajouts encombrants, mal adaptés et peu sécuritaires. Plusieurs arguments d'ordre économique et financier viennent par ailleurs appuyer cette démarche en faveur des personnes âgées ou handicapées. Notamment, que le développement de telles aides ne manquera pas de favoriser leur commercialisation auprès de l'ensemble des utilisateurs.

17. Mots clés
Personnes âgées, personnes handicapées, Micro-électronique, Systèmes routiers intelligents, Ergonomie, Systèmes avancés d'information routière embarquée, Aides à la conduite de véhicules, Aides à la navigation routière, Système de guidage, Véhicules adaptés, Ordinateurs de bord.

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EXECUTIVE SUMMARY

Literature review indicates that the number of people 65 and older will nearly double by the year 2030 as a result of the aging of the baby boom generation. It has also been established that, for many, driving skills start to deteriorate around age 50, even more clearly around age 75, resulting in an increase in both crash involvement and fatality rates. Many of the crashes are caused by perceptual and cognitive difficulties leading to two types of driver error: overlooking traffic signals and signs, and breaching right-of-way rules. The increased crash involvement, in part, explains the further projections that the number of severely disabled will also increase.

These future seniors will have grown up in a highly mobile society, with many driving automobiles since they were teenagers or young adults. Restrictions on individual mobility will therefore be hard fought. For the elderly and disabled living in rural settings, with limited or no accessible public transport service, any limits on driving will have particularly severe implications.

There clearly is a need to:

* improve accessibility to private vehicle travel, both as a driver and a passenger, and make travel more predictable
* improve physical access to public modes and enhance information about their services and transfer facilities
* increase safety and security during the full length of each trip, including access/egress by walking and wheelchair and maneuvers within parking and terminal facilities
* make travel more enjoyable by reducing overall transportation stress and by improving access to information, activities and services.

Based on this exploratory investigation, the deployment of advanced micro-electronic technologies seems to hold great promise in every aspect of travel and within all modes of transport. Some of these technologies will provide compensation for deficits in human senses and abilities to the point where independent mobility becomes safe, legal and practical.

The potential features, available through micro-electronic hardware and software technologies, have been categorized into seven functional areas: travel advisory and navigation;

specialized transportation advisory; vehicle monitoring, safety and performance; vehicle control; driver monitoring and assist; primary driving controls; and secondary driving controls. The report further documents specific application packages - ranging from simple accessible entrance locators, to enhanced night vision systems, and driver monitoring and advisory systems - that might be considered for development.

A concept plan for a future in-vehicle information/management /control/communications system, designed to assist elderly and disabled drivers and passengers, is presented. It incorporates conventional mobile information system features with functions designed to meet many special needs.

It is recognized that a significant research, development and demonstration effort is required to accelerate the availability of these systems. Four priority project areas are recommended - to form the core of elderly/disabled research in Intelligent Vehicle-Highway Systems (IVHS) technologies and applications. These cover human factors/ergonomics, advanced traveller information systems, advanced vehicle control systems, and traveller decision making.

The deployment of these systems can be expected to significantly contribute to enabling persons with physical, sensory, cognitive, mental or other disabilities - as well as elderly people in general - to lead more productive and satisfying lives through increased mobility, self-sufficiency, comfort and security. In some cases, these systems will facilitate deinstitutionalization and access to employment - or at least a longer, independent stay in private residence.

It is essential, however, that the needs of elderly and disabled persons are identified early in the development of micro-electronic systems and in-vehicle devices - and not just as an afterthought, which would surely result in cumbersome, user-unfriendly, and unsafe retrofits.

There are also sound economic and business reasons to recognize elderly and disabled requirements now, as it will significantly enhance the marketability of the devices to the users-at-large - while ensuring a road safety focus throughout the development process.

SOMMAIRE

On sait grâce aux statistiques que, d'ici l'an 2030, la population âgée de 65 ans et plus, composée des personnes nées immédiatement après la Seconde Guerre mondiale, aura presque doublé. On sait aussi que les aptitudes à conduire une voiture commencent à se dégrader pour certains vers l'âge de 50 ans et beaucoup plus certainement autour des 75 ans, comme le prouve l'incidence accrue de ce groupe d'âge dans les taux d'accident avec et sans tués. Il s'agit surtout d'accidents attribuables à une dégradation des facultés perceptives et cognitives menant à deux types d'erreur humaine : non observance de la signalisation et infraction au droit de passage. Cette incidence accrue explique en partie l'augmentation prévue du nombre de personnes atteintes d'incapacité profonde.

On peut dire de cette génération qu'elle a grandi au sein d'une société fortement motorisée, ayant acquis très tôt dans la vie l'habitude de conduire une voiture. Il lui sera difficile d'accepter l'idée de ne plus pouvoir conduire. Et encore plus difficile pour les personnes âgées ou handicapées vivant hors des zones urbaines.

Des moyens doivent donc être pris pour :

- rendre les déplacements par véhicule privé accessibles à ces personnes à titre de conducteur ou de passager, et faire en sorte que se déplacer puisse relever de la réalité courante;

- améliorer l'accessibilité des transports collectifs et diffuser l'information nécessaire concernant les services fournis et les correspondances;

- renforcer la sûreté et la sécurité des déplacements, du début à la fin, à la montée ou à la descente, à pied ou en fauteuil roulant, dans les stationnements ou dans les installations terminales;

- redonner le goût de se déplacer, en réduisant les contraintes inhérentes et en rendant plus facile l'accès à l'information, aux services, aux activités.

Cette recherche exploratoire a montré qu'il est possible d'entrevoir des applications intéressantes de la micro-électronique en transports, dans tous leurs aspects et quel que soit le mode considéré. Il n'est pas impossible, non plus, que grâce à telle ou telle technologie, diverses déficiences sensorielles ou motrices finissent par être comblées et que l'utilisateur se sente assez sûr de lui-même pour entreprendre en autonomie des déplacements qui soient sûrs, intéressants et sans risque d'infraction.

Les applications que les progrès de la micro-électronique permettent d'envisager relèvent des sept secteurs fonctionnels suivants : systèmes d'information et aides à la navigation; systèmes d'information dédiés aux transports; systèmes de suivi de la sûreté et des performances du véhicule; aides à la conduite de véhicules; aides à la vérification et à l'entretien des véhicules; systèmes de commande principaux et systèmes secondaires de commande. Le rapport décrit quelques applications spécifiques, allant de la localisation des entrées accessibles aux dispositifs de vision nocturne améliorés, en passant par les aides à la conduite et l'information routière embarquée.

Le rapport décrit le concept d'un système embarqué d'information et de communication, de gestion et de commande, destiné aux personnes âgées ou handicapées qui conduisent leur propre véhicule ou qui voyagent à titre de passagers, ce système possédant les fonctions et les caractéristiques d'un système de communication mobile classique mais adapté aux besoins de cette clientèle particulière.

Un ambitieux programme de R&D sur les applications de la micro-électronique aux transports sera nécessaire pour hâter leur développement. Quatre axes de recherche sont proposés, à entreprendre en priorité dans le cadre du programme de R&D sur les systèmes routiers intelligents et visant à accroître la mobilité des personnes âgées ou handicapées. Ces quatre axes sont : les facteurs ergonomiques, les systèmes avancés d'information routière embarquée, les aides à la conduite et les aides à la prise de décision en matière de déplacements.

Il est fort possible que la mise en oeuvre des technologies fondées sur la micro-électronique parvienne à améliorer grandement le sort des personnes ayant une incapacité physique, sensorielle, cognitive, mentale ou autre, ainsi que celui des personnes âgées, et qu'elle leur permette de mener une vie plus productive et agréable, grâce à une mobilité et une autonomie accrues, dans le confort et la sécurité. Il est également possible que, dans certains cas, ces aides favorisent la mise hors institution des personnes qui les utilisent, et qu'elles leur permette de trouver un emploi rémunéré, ou de mener une vie autonome dans un foyer privé.

Mais il faut savoir que la prise en compte des besoins des personnes âgées ou handicapées doit intervenir tôt dans le processus de développement de toutes ces aides, embarquées ou non, pour ne pas risquer d'en faire de simples ajouts encombrants, mal adaptés et peu sécuritaires.

Plusieurs arguments d'ordre économique et financier viennent par ailleurs appuyer cette démarche en faveur des personnes âgées ou handicapées. En effet, le développement de telles aides ne manquera pas de favoriser leur commercialisation auprès de l'ensemble des utilisateurs, tout en plaçant le processus de développement dans une optique de sécurité routière renforcée.

TABLE OF CONTENTS

	Page
INSIDE COVER	i
DISCLAIMER	ii
PUBLICATION DATA FORM	iii
FORMULE DE DONNEES POUR PUBLICATION	iv
ACKNOWLEDGEMENTS	v
EXECUTIVE SUMMARY	vii
SOMMAIRE	ix
TABLE OF CONTENTS	xi
1. INTRODUCTION	1
1.1 BACKGROUND	1
1.2 OBJECTIVE	1
1.3 SCOPE	1
2. CURRENT CIRCUMSTANCES	2
2.1 THE SETTING	2
2.2 DISABILITY CATEGORIES	3
2.3 TRAVEL CATEGORIES AND AIDS	4
2.4 CURRENT SERVICES	7
3. MICRO-ELECTRONICS APPLICATIONS	8
3.1 INTRODUCTION	8
3.2 ADAPTATION COST	9
3.3 PHYSICAL EFFORT	9
3.4 TRAINING REQUIRED	10
3.5 MODIFIED CONTROLS	11
3.6 AUDIBLE COMMUNICATIONS	11
3.7 VISUAL ACUITY	12
3.8 PLANNING INFORMATION	13
3.9 SIGNAGE	13
3.10 DECISION MAKING	14
3.11 MULTI-TASKING	15
3.12 SAFETY AND SECURITY	15
3.13 MICRO-ELECTRONICS APPLICATIONS	16

4. FUTURE SYSTEM CONCEPT 17

4.1 POTENTIAL DEVELOPMENTS 17

4.2 CONCEPT DESIGN 17

4.2.1 Controls (Inputs) 17

4.2.2 Displays (Outputs) 22

4.2.3 On-Board Computer 23

4.2.4 Navigation Sensors and Receivers 25

4.2.5 Vehicle Control Sensors, Actuators and Servos 25

4.2.6 Occupant Condition and Environmental Sensors and Actuators 26

4.2.7 Activity Modules 27

4.2.8 Map Data Base 27

4.2.9 External Communication Modules 27

5. RECOMMENDATIONS 28

BIBLIOGRAPHY 33-38

APPENDICES

A PRELIMINARY LIST OF FUNCTIONS AND FEATURES A1-A6

B MICRO-ELECTRONICS APPLICATIONS B1-B14

C REPRESENTATIVE SYSTEMS C1-C3

EXHIBITS

1. DEFINING THE DRIVING-HANDICAPPED POPULATION 5

2. MICRO-ELECTRONICS APPLICATIONS FOR E&D TRAVELLERS Development Status & Potential 18-20

3. FUTURE MOBILE SYSTEM FOR ELDERLY AND DISABLED A Functional Block Diagram 21

APPLICATION OF MICRO-ELECTRONIC TECHNOLOGY TO ASSIST ELDERLY AND DISABLED TRAVELLERS

1. INTRODUCTION

1.1 BACKGROUND

This project was designed to provide an exploratory investigation into specific micro-electronic technologies (state-of-the-art hardware and software) that can best be adapted for both personal usage and usage on-board road vehicles - and to identify those system functions and capabilities which have the potential to:

* improve the mobility of seniors and persons with disabilities
* increase personal safety and security
* make travelling by motorized means more enjoyable.

The overall goal, towards which this project was designed to contribute, is to enable persons with physical, cognitive, and medical or mental disabilities to lead more productive and satisfying lives through increased mobility and self-sufficiency - and, where possible, to facilitate deinstitutionalization and employment, or at least to lengthen their stay in private residences.

1.2 OBJECTIVE

The objective of this exploratory investigation was to identify those advanced micro-electronic technologies that can be applied to private and public transport vehicles and systems in a way that will make travel easier, safer and more predictable for seniors and persons with disabilities, and that will improve their access to information, activities and services.

1.3 SCOPE

The primary focus of this report is on technology suitable for personal vehicle operations. Related applications - which will further reduce overall transportation stress - have been

identified for the public transport modes (urban and inter-city transit vehicles, terminals and reservation systems), for road networks and traffic management systems, and for activity centres, facilities and accommodations along the travel route. Since all trips begin and end in the pedestrian mode of travel, attention has been given to personal mobility aids. It is anticipated that some technology may increase human senses to the point where independent mobility is safe, legal and practical. Such technology could permit drivers or potential drivers to overcome marginal disabilities and constraints that prevent or discourage independent trip-making.

2. CURRENT CIRCUMSTANCES

2.1 THE SETTING

The Canadian Health and Disability Survey 86/87 (Ref: 11) indicated that about 13.2% of the Canadian population or 3 317 000 persons are disabled. Among Canadian adults, the survey reported that 3 039 000 persons have some degree of disability. Of these, some 66% or 2 002 000 persons have some constraint or constraints upon their mobility.

With the aging of the baby boom generation (children born just after World War II), the percentage share of those whose driving skills are diminished by age is rising quickly. By 2030, the percent of people 65 and older will nearly double - from roughly 12% to 22%. This is significant since both crash involvement and fatality rates start rising already around age 50 - caused by increasing perceptual and cognitive deficits leading to, typically, two types of driver error: disregarding traffic signals and signs, and right-of-way violation (Ref: 87). This, in part, explains the further projections that the number of severely disabled will also increase.

Such persons can be grouped by the barriers to their mobility that must be reduced or overcome to satisfy their travel objectives. Typical constraints include:

* cost of vehicle adaptations (factory & retrofit devices)
* modifications required to the controls (current state-of-the-art)
* physical effort required to operate original and adapted controls
* initial training and periodic retraining required

* audibility of messages and/or voice commands in an automotive environment
* acuity (vision) and hearing levels, and memory skills
* information on traffic conditions (required for active, individualized route guidance)
* visibility and recognition of traffic and street signs and dwelling numbers
* decision making ability under duress (in heavy traffic)
* ability to process information and execute appropriate responses in a multi-tasking environment.

The degree to which a system or device can assist in overcoming one or more of the above constraints can be used as a measure of the importance of developing such technology. Another measure would be the potential numbers of person-trips that could be accommodated. Other considerations include:

* cost of research, development and manufacturing
* potential sales (mass markets), and economic benefits
* potential for integration with other technologies to reduce information overload
* suitability for training and retesting of elderly and disabled drivers
* contribution to overall safety and security.

Since the current elderly and disabled have grown in a highly mobile society, with many driving automobiles since they were teenagers or at least young adults, any restrictions on individual mobility will be hard fought. The implications will be particularly severe for those living in rural settings. As the society can ill afford to replace all that private vehicle mobility with totally accessible, high level service by public modes, the accelerated development of advanced microelectronic technologies to respond to their travel needs will be of critical importance.

The most successful development projects are likely to result from applications of technology that would appeal to other segments of the population. The development of products and services that can be used to advantage by seniors and others would increase the potential for mass production. For example, technology that reduced noise levels, stress and fatigue would appeal to large segments of the population. Economic benefits would increase from technology with such broad application. Standardization and mass production would ensure

that these products and services could be afforded by low income segments.

2.2 DISABILITY CATEGORIES

The following are the types of disabilities reported by the 3 039 000 persons aged 15 or over in the 1986/87 Canadian Health and Disability Surveys (Ref 46):

		Approximate Percent of	
		Disabilities	Population
- mobility	2 002 000	31%	66%
- agility	1 747 000	27%	58%
- hearing	974 000	15%	32%
- visual	547 000	9%	18%
- speech	243 000	4%	8%
- mental/other	741 000	12%	24%
- unknown disabilities	122 000	2%	4%
	6 376 000	100%	210%

The numbers of disabilities reported are greater than the numbers of persons with disabilities by a factor of 2.10. This indicates the degree to which these persons experience ***multiple disabilities.***

2.3 TRAVEL CATEGORIES AND AIDS

The reported mode of travel regularly used by the 2 448 000 adults in the 1983/84 Canadian Health and Disability Survey was as follows:

- self-drive	938 000	38.3%
- auto passenger	682 000	27.9%
- taxi	40 000	1.6%
- transit	546 000	22.3%
- paratransit	26 000	1.1%
- not able to travel	216 000	8.8%
	2 448 000	

The reported use of adapted vehicles and other mobility aids was as follows:

- adapted vehicles (special features)	16 000	persons
- wheelchairs	75 000	persons
- walking aids	325 000	persons
- hearing aids	150 000	persons.

Since the adaptive equipment and vehicle market will soon be North-America wide - as defined by the free trade agreement - another useful perspective on target populations can be presented by combining U.S. and Canadian numbers (Exhibit 1). A total market potential of perhaps 21.2 million is indicated.

The *conventional adaptations* needed to enable young people with disabilities to drive, typically include (Ref: 64):

- seat modifications (raised, side support)	spina bifida (with and without hydrocephalus), myopathy, cerebral palsy; congenital (birth-rltd)limb deformity
- steering aid (ball grip)	spina bifida, cerebral palsy (CP)
- power steering	myopathy (ie. muscular dystrophy)
- hand accelerator/brake	almost all spina bifida, majority of CP, half of myopathy
- automatic transmission	virtually all.

Young adults, who have become disabled through an accident or the onset of disease, typically require:

- hand controls	neuro-muscular diseases (multiple sclerosis, post-polio) & spinal lesions
- servo-assisted braking and hand controls & high gain/low effort power strng & grip aids	spinal injuries with high level of lesion (quadriplegics)
- joy-stick controls & wheelchair mounts	people with very limited hand power who may also drive from wheelchair (post-polio, muscular dystrophy or high lesion quadriplegics)
- intense retraining & driving restrictions & electronic systems	cognitive and perceptual impairments (brain-damaged young adults).

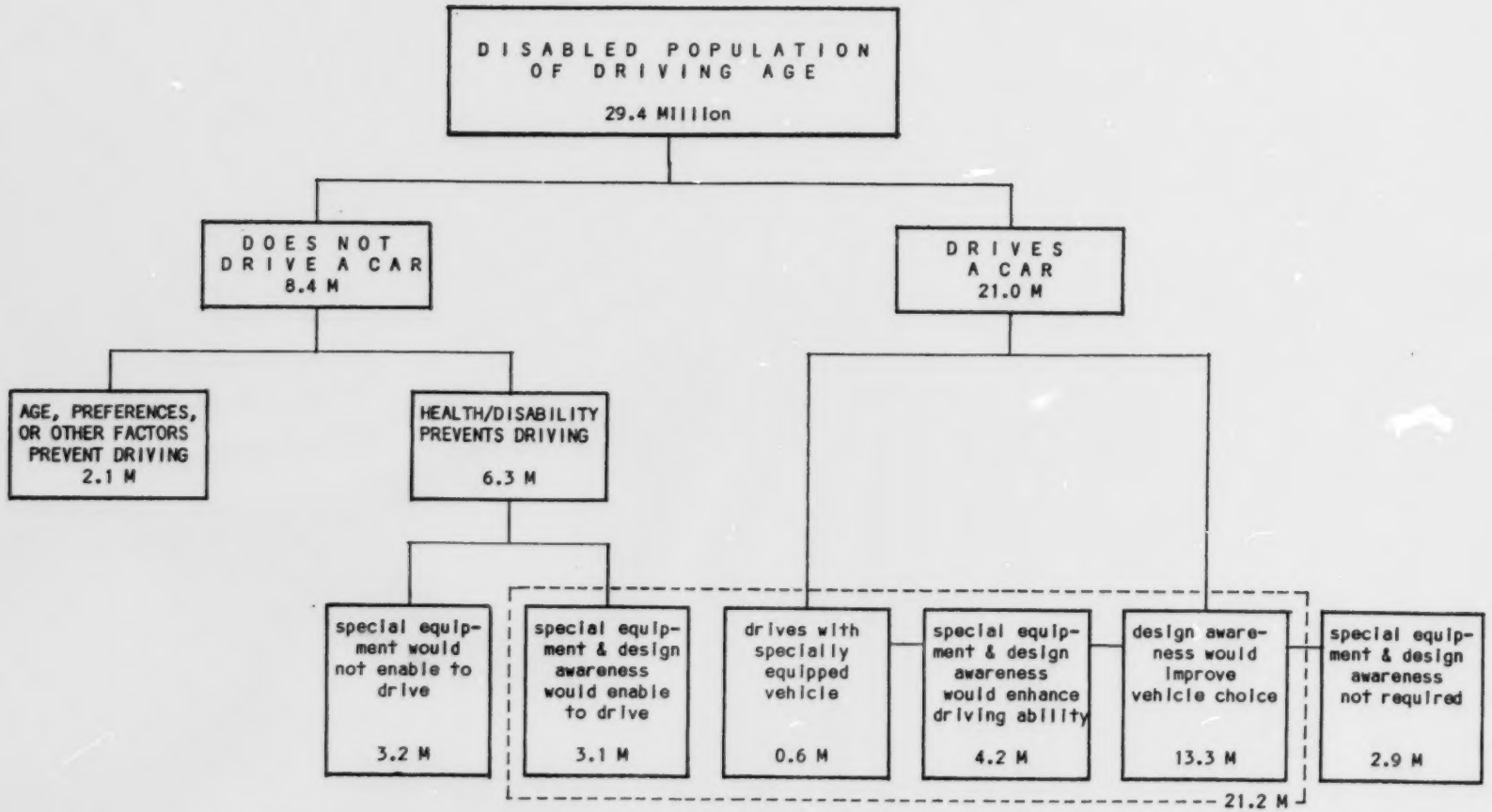
Older people with age-related disabilities typically require:

- seat modifications (head rest) & tailor-made power steering & servo-assisted brakes	rheumatoid arthritis

EXHIBIT 1

DEFINING THE DRIVING-HANDICAPPED POPULATION

- U.S.A. & Canada -



Source: Market Strategies to Expand the Ownership of Private Vehicles by People with Disabilities
David Lewis/Hickling Corporation & Ling Suen/TDC/Transport Canada; prepared for TRRL Seminar on Private Transport for Elderly and Disabled People, 24-25 June 1991.

-	hand accelerator/brake controls	osteo-arthritis
-	intense retraining & highly restricted driving times/places & advanced electronic systems.	cognitive (reasoning, memory) and perceptual impairments

2.4 CURRENT SERVICES

Current experience with the application of micro-electronic technology to assist travellers with disabilities suggests opportunities for further research and development. Such technologies include:

* personal assist devices
  - personal audio, vision and speech aids
  - security alarms and personal monitoring systems
  - medical alert systems
  - specialized telephone technology for hearing impaired persons
  - voice-activated electronic notepad
* pedestrian assist devices
  - direction sensing canes for visually impaired persons
  - audible traffic signals for visually impaired persons
  - intelligent traffic control systems (which have the capability of varying crosswalk timing)
* public information systems
  - cellular telephones
  - automated and intelligent telephone information systems (e.g. ITIS / Ref: 33)
  - fixed terminal communication systems such as COMMUNICAID and TRANSLAID which assist in communications with disabled travellers (Ref: 33)
* in-vehicle operation/training devices
  - keyless lock and entrance security systems
  - driver denial systems
  - automobile seats and controls that "remember" their default positions or respond to smart card commands
  - automated seat belt system
  - automobile monitoring, environmental control and diagnostic alert safety systems
  - automobile collision avoidance systems
  - driver testing and training technology for drivers with disabilities

- technologies for retesting/retraining of elderly and brain-damaged drivers (e.g. using simulators /Ref: 84)

* traffic flow/management system
  - automated billing machines for parking and toll booth charges (interrogator units & vehicle I.D. tags)
  - automated freeway ramp monitoring technology, including state-of-the-art IVHS (intelligent vehicle-highway systems) or RTI (road transport informatics)
  - changeable message signs
* travel orientation/information/communication systems
  - existing road maps, and manual travel guides to accessible transport, accommodation and services
  - automated weather and road status systems
  - vehicle locator systems (e.g. based on Loran-C or on autonomous location/navigation technologies)
  - in-vehicle map display systems for navigation
  - systems to provide vehicle-specific route guidance
  - electronic billboard display systems
  - citizens' band and short-wave radios, and cellular telephones.

3. MICRO-ELECTRONICS APPLICATIONS

3.1 INTRODUCTION

The constraint categories listed in Section 2.1 have been at least partially overcome, for many persons with disabilities, by better mobility aids and improved industrial and architectural design. For others, including those who depend upon specialized technology, potential applications of micro-electronics can be visualized in every aspect of travel and for all modes of transport. A list of desirable functions and features for new applications of micro-electronic technology to enhance all aspects of personal mobility is presented in Appendix A, grouped under the following headings:

- travel advisory / navigation systems
- specialized transportation advisory
- vehicle monitoring/safety/performance
- vehicle control
- driver monitoring/assist
- primary driving controls
- secondary driving controls.

A short rationale and example applications are presented, for each of the constraint categories, in the following:

3.2 ADAPTATION COST

The adaptation of standard production vehicles to meet special needs is very costly. An analysis of some 300 adapted vehicles in operation in California concluded that "no two vehicles were exactly alike" and that "only a small percentage of those in need are able to receive (afford) adapted vehicles" (Ref: 65). A partial solution to the cost constraint would therefore appear to be in developing adaptive solutions that incorporate existing vehicle technology and "after-market" options, or in encouraging solutions that have wider application and therefore could become industry standards. In each case, all possibilities to use large two-door cars instead of only vans should be exploited. Where possible, solutions that can be fitted to all types of vehicles ought to be sought (disabled and elderly persons desire the same range of vehicles as able-bodied to match life-style).

Such applications could include: improvements in the reliability of existing control systems, location of more instrumentation and controls on the steering column, improved ergonomic design, simplification and integration of multi-functional controls and on-board information and navigation aids.

3.3 PHYSICAL EFFORT

There is substantial physical effort involved for many seniors and disabled persons in locating accessible entrances, boarding their personal vehicles and in steering their vehicles, particularly while operating at low speeds and when parking. Micro-electronic technology that can be used in control devices that multiply physical effort has proven useful and appears to have even further potential. Devices that would benefit all drivers, including commercial transport drivers, would likely become an industry standard. Communications devices (e.g. beacons at large complexes) that reduce or eliminate circuitous pedestrian access would also be valuable.

3.4 TRAINING REQUIRED

One of the constraints to the personal mobility of severely disabled persons is the time and cost required to learn to operate complex automotive steering, throttle and braking systems. There is substantial room for improvement in the operation and reliability of these special controls. There is also a need to develop standard technology for testing of driving ability under multiple tasks. A prototype computerized driver assessment module has been developed at G.F. Strong Rehabilitation Centre in Vancouver and the University of British Columbia (Ref: 50).

A sophisticated vehicle simulator, under development at Concordia University, is intended for the assessment and training of disabled and elderly drivers (Ref: 84). Such assessments can help identify where blockages due to information-processing deficits exist, and what exercises and cognitive training are needed. Although limited testing is already underway, these technologies are still in the early development stages. For the simulator, for example, further development of the visual, force feel, assessment and training systems, in addition to a more 'user-friendly' instructor's facility, are indicated - in order to arrive at a commercially viable product which is affordable to driver assessment facilities.

Retraining requirements often arise also with elderly drivers; at the death of a spouse, who has been the (family) driver for many years, the living spouse is suddenly left to cope with new mobility demands. She or he will need to relearn driving - or, at least, learn to drive in traffic and road network environments far more complex than may have been the case in the immediate neighbourhood (e.g. when grocery shopping). Canada Safety Council organizes comprehensive refresher courses for mature drivers under the name "55 ALIVE/ MATURE DRIVING".

Periodic retesting - and retraining, ranging from periodic retraining to continuous advisories received from an on-board computer while driving - are also indicated where driving skills are slowly deteriorating. Ontario's driver licensing rules, for example, already require age-based re-examination.

3.5 MODIFIED CONTROLS

An adapted vehicle may require modifications to four basic control systems:

- throttle, brake and steering system
- electrical control system
- wheelchair lock system
- entry system.

There are potential applications of micro-electronic technology in all four of the above systems. At present, vehicle manufacturers are offering keyless entry systems. More controls are being mounted on the steering column and considerable work has been done on wheelchair lock/security systems. Electronic instrumentation remains fairly costly and somewhat less reliable than manual instruments. Audio receiver and music systems have become considerably more complex and less accessible.

The areas where further improvements in function and cost could be achieved are likely to be in the refinement of multiplexed controls and fail safe devices. It is also not clear whether the vehicle adaptors in Canada are aware of all of the technology that is available.

3.6 AUDIBLE COMMUNICATIONS

Improvements in the audibility of communications and the reinforcement of audible communications with visual signals and message displays has great potential for refinements of existing technology and the development of new technology. A recent workshop on access to transportation for persons with hearing disabilities summarized the needs and constraints (Ref: 61).

- need more special telephone equipment in terminals because of difficulty in using existing equipment
- cannot "hear" fire alarms without visual signals
- need adequate lighting for "eye to eye" contact with vehicle operators and counter staff
- need visual signals and typed text on monitors, particularly when travel times, routings and departures are changed

- need universal phone plugs so personal TDD phones can be used in hotel rooms
- need improved public address system acoustics in terminals and on mass transit vehicles
- need devices at information/reservation counters that aid listening
- need captions on video announcements in aircraft.

Other vehicular applications included clearance sensing devices, routing information, and security and medical emergency alerts. Recent research suggests that while the aural channel is most important (safe) for most in guidance and alert/advisory messages, multi-channel techniques will significantly increase the safety-in-use - i.e. the use of simplified visual, and even physical sensory (touch) cues to complement speech, tones and chimes.

3.7 VISUAL ACUITY

Research into accident frequencies of aging drivers by the Insurance Corporation of British Columbia (ICBC) and others has identified the lack of visual acuity under low light conditions to be a significant factor (Ref: 5, 27). Drivers who pass standard acuity tests may experience a substantial decrease in acuity at night and under conditions of reduced visibility due to fog or precipitation. At present there is no established method of simulating such conditions for testing purposes (although the TDC-sponsored simulator is starting to provide some of these functions). A substantial number of drivers avoid driving under these conditions. What the ICBC study revealed was that some persons who normally would not drive under low light levels will do so in an emergency or when alternatives are not available, with disastrous consequences.

Potential for the development of improved safety could come in several areas:

- improvements in personal vision aids
- improvements in information from auto instrumentation
- reduction in glare within vehicles and from signage
- improvements in street lighting
- the use of advanced warning systems including audible sign reinforcement

- improvements in signage (discussed under Section 3.9)
- a variety of barrier detection systems: front, side, rear, and above vehicle (e.g. raised van roofs)
- denial of access to private automobile under low light conditions (similar to proposed breathalyser denial systems)
- routing display systems to minimize difficult turns and hazardous intersections.

Particularly in light of the above expected developments, there is an urgent need to develop dynamic visual acuity testing (to complement current static systems).

3.8 PLANNING INFORMATION

Further development in personal communications terminals and intelligent telephones holds great potential for overcoming travel constraints to seniors and persons with disabilities (Ref: 2). The major constraint is likely to be the cost of such technology until mass production of standard technology is achieved. Development of portable receivers that can plug into standard outlets in transportation vehicles and terminals would extend the capability of existing technology. The need for similar outlets to accommodate personal telephone technology was noted previously under Section 3.6.

With latest IVHS-type in-vehicle devices - such as CD-ROM (compact disc - read-only memory) based navigation/route guidance/information systems - designs which allow transferring the device from the vehicle to the residence or office, will greatly enhance trip planning - not only for elderly and disabled persons, but for all users. The map display and routing functions can then be called into action prior to a trip - for the purpose of planning and learning about the upcoming travel challenges in the peace and quiet of a home or office. While this will increase the safety-in-use for all drivers, for elderly and disabled persons the chance to plan without the pressure of navigating in traffic at the same time will be truly valued.

3.9 SIGNAGE

The majority of problems with signage have to do with physical characteristics such as: size and type of characters,

sign placement and consistency of placements, lighting, reflective materials and message repetition. Opportunities for message reinforcement through micro-electronic technology exist. For example, where a sign contains numerous small-print rules (e.g. hours of parking restrictions) and the traffic situation does not allow first driving to the sign to study it, an in-vehicle transponder module that allows reception of the sign's (electronic) content can be invaluable. It will help, for example, those individuals for whom exiting the vehicle to study the sign, and having to re-enter the vehicle in order to continue to look for another parking site, is prohibitively stressful.

In addition, it may be possible to monitor environmental conditions and adjust sign lighting and visibility through infra-red vision technology. The matter of sign visibility is a highly specialized subject upon which substantial research documentation is readily available. (Ref: 79)

3.10 DECISION MAKING

Most travel involves more than one mode. Even a short trip by bus or auto requires both pedestrian and vehicle modes. In Vancouver, for example, a transit trip by a person with a disability could involve five modes of travel:

- pedestrian
- paratransit
- road transit (bus or trolley).
- marine (ferry)
- rail transit

An inter-city trip could include the following modes:

- pedestrian
- taxi or bus
- aircraft or ferry
- limousine or paratransit.

A person with disabilities must therefore make travel decisions based on information and experience regarding all of the modes involved in a trip, as well as the terminal facilities, the transfers between modes and any level changes involved. This complex decision-making process must be based on information from a variety of sources with varying degrees of accuracy and completeness. Often conflicting data is presented requiring a judgement by the consumer. Some persons are overwhelmed by the task. This experience suggests substantial potential for improved communications technology.

3.11 MULTI-TASKING

The way in which information is presented influences the decision process. For example, a driver must absorb multiple inputs from vision, hearing, touch, vibration and even smell to successfully operate a motor vehicle. (Visualize an overheating engine or brakes on a downgrade with conflicting pedestrians and vehicles, traffic signs, signals, speed bumps to slow traffic and a tire going flat at the same time!)

To overcome a complex multi-task environment in an aircraft cockpit, techniques have been developed to display instrument readings in the windshield. This "heads-up" technique is currently being investigated for automobile applications. (Ref: 44)

It may be possible to reduce the multiplicity of tasks required of disabled drivers by simplifying the instrument displays. A hierarchy of information flow could be developed using military and civil aviation techniques so as not to overload the driver. Fail-safe equipment could be employed in some cases so emergencies are avoided. Considerable research is required before any development occurs.

3.12 SAFETY AND SECURITY

Among the other considerations used to evaluate potentially useful technology are the factors of safety and security, both for pedestrians and for those who operate motor vehicles. For pedestrians the most important systems are those, such as loud alarms and mobile telephones, which can summon emergency medical or security assistance in most situations.

Vehicle locator devices may be important as a driver or passenger may not know their location in case of vehicle breakdown or when away from the vehicle. Systems that combine automatic vehicle identification (AVI), and automatic vehicle location (AVL) such as Loran-C, are being investigated for use by disabled travellers. An extension of in-vehicle systems to cover out-of-vehicle emergencies will also be useful. For positioning, in such cases, satellite (or Loran-C) based systems are required. Autonomous in-vehicle systems cannot be removed in the same sense (i.e. to become a wheelchair attachment).

3.13 MICRO-ELECTRONICS APPLICATIONS

Fourteen enhanced or new potential applications of micro-electronics to improve the mobility of seniors and persons with disabilities are presented in Appendix B. These include devices that would reduce physical effort required to operate automobiles, personal assist devices for pedestrians, and technology intended to improve the safety of travel by a variety of modes. Most of the applications described would also benefit the general population and therefore have good potential for mass production. In most cases initial research has been carried out, but further development and demonstration is required. The 14 applications are:

1 Variable Effort Power Steering
2 Accessible Entrance Locator
3 Interactive Tactile System
4 Personal Reminder/Locator
5 Enhanced Public Address System
6 Personal Locator
7 Personal Rider Information System
8 Personal Video/Audio Station
9 Enhanced Night Vision
10 Visual Signal and Message Systems
11 Trip Planning Data Base
12 Personal Translator
13 Driver Information System Organizer
14 Driver Monitoring and Denial System.

The descriptions of these new devices and products is in the form of product specifications. For each application, the following factors are covered:

- target market
- population segment
- objective
- scope of application
- performance specification
- consumer benefits
- other benefits
- development requirements.

In many ways, the above fourteen micro-electronics applications constitute a "wish list"; no attempt has been made as of yet to select priorities for research and development among this group.

4. FUTURE SYSTEM CONCEPT

4.1 POTENTIAL DEVELOPMENTS

Current applications of micro-electronic technology already include numerous functions in communications, micro-computer assisted systems, vehicle adaptations, and personal mobility aids. Most likely near-term developments include simplification of design to increase reliability and reduce cost, system integration (of complementary features), standardization of features between in-vehicle and external devices, and the introduction of multi-functional portable devices. Current development status and some of the likely potential advancements are summarized in Exhibit 2.

4.2 CONCEPT DESIGN

A future in-vehicle information/management/control system designed to assist elderly and disabled drivers and passengers would incorporate conventional mobile information system features with special functions designed to meet the E&D needs. A functional block diagram for one such concept design is presented in Exhibit 3.[1]

4.2.1 Controls (Inputs)

To accommodate drivers with disabilities who require adapted vehicles with hand and other controls, several additional micro-electronics supported functions may be needed - many of which may incorporate smart card driven personalized 'initializations'. These could include:

- auxiliary controls for entry (automatic door and trunk opening/closing, seat positioning), for rear and side view mirrors positioning (with automatic glare control at night), and for controls of wheelchair lifts, ramps, and locks (note: special entry and/or entry denial controls and other security features may also be provided)
- multiplexed control switches for starting the vehicle, turn signals, horn, windshield wipers, interior and exterior lighting, and headlight dimmer

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1) Modified from Exhibit 27, MOBILE INFORMATION SYSTEMS IMPACT STUDY, Jouko A Parviainen/Parviainen & Associates; for Ministry of Transportation Ontario & Transportation Development Centre/Transport Canada; TP 9360E, August 1988.

EXHIBIT 2

MICRO-ELECTRONICS APPLICATIONS FOR ELDERLY AND DISABLED TRAVELLERS

- DEVELOPMENT STATUS & POTENTIAL -

DEVELOPMENT STATUS	POTENTIAL
TELEPHONE COMMUNICATIONS SYSTEMS	
Major components of benefit to persons with physical and hearing disabilities are fully developed and available commercially, e.g. - cellular telephones - text based teledevices for the deaf (TDD) - stationary and portable telephone amplifiers - auxiliary visual signalling devices - telephones with oversize dialing buttons - telephones operated by mouth stick - emergency alert systems - one touch dialing systems - stored message systems - picture or symbol dialing system - visual light pulse message systems - digitized electronic speech	Aggressive development and marketing programs will likely continue making new and improved products available. Best potential is in system integration, standardization and greater application in public buildings and terminals.
MICRO-COMPUTER SYSTEMS	
Substantial application of existing micro-computer technology to overcome physical disabilities exists. Agencies such as the Neil Squire Foundation in Vancouver are integrating micro-electronics devices to perform tasks. Available technology includes: - speech recognition systems - voice driven word processing - voice driven servo systems - mouth stick driven systems - light interruption system drivers - muscle spasm system drivers - eye level personal CRT display - text to speech systems - environmental control systems - emergency alert and security systems	Applications of control system technology will likely accelerate as new and improved control modules become available and system costs decline. Best potential appears to be in integration of intelligent systems, development of peripheral controls and improvements of portability in existing technology.

EXHIBIT 2 (continued)

MICRO-ELECTRONICS APPLICATIONS FOR E&D TRAVELLERS
- DEVELOPMENT STATUS & POTENTIAL -

DEVELOPMENT STATUS	POTENTIAL
VEHICLE ADAPTATION	
There are three major areas of development: - multiplexed vehicle controls - on-board computer applications - auxiliary digital controls	-
Multiplexed Vehicle Controls: Hand operated command and control modules integrating motorized steering, electric shifting, acceleration and braking, turn signals, horn operation and headlight controls are commercially available. Push/pull acceleration and braking can be accommodated with joy stick or trigger controls.	Further development to simplify, standardize and reduce the cost of adaptive technology is needed. Current applications are custom designed using available components. A universal system that could be adjusted to individual needs would lower costs.
On-Board Computer Applications: To date on-board computers have been used only to control drive-train operations, diagnose faults and operate the servo devices for hand-controlled vehicles. On-board map display systems were developed for police applications about 25 years ago, but have not been utilized as aids to mobility for E&D travellers. Considerable research continues into inter-active communication systems.	Significant opportunities exist for the development of personal display systems. Such systems are only being used in public transportation vehicles at present. Existing map information needs to be condensed for disabled persons.
Auxiliary Digital Controls: A variety of auxiliary controls are commercially available to control ignition, lighting, windshield wipers, heating and air conditioning, radio, etc.	Further multiplexing of controls is desirable. Integration of controls with system status indicators is also desirable.

EXHIBIT 2 (continued)

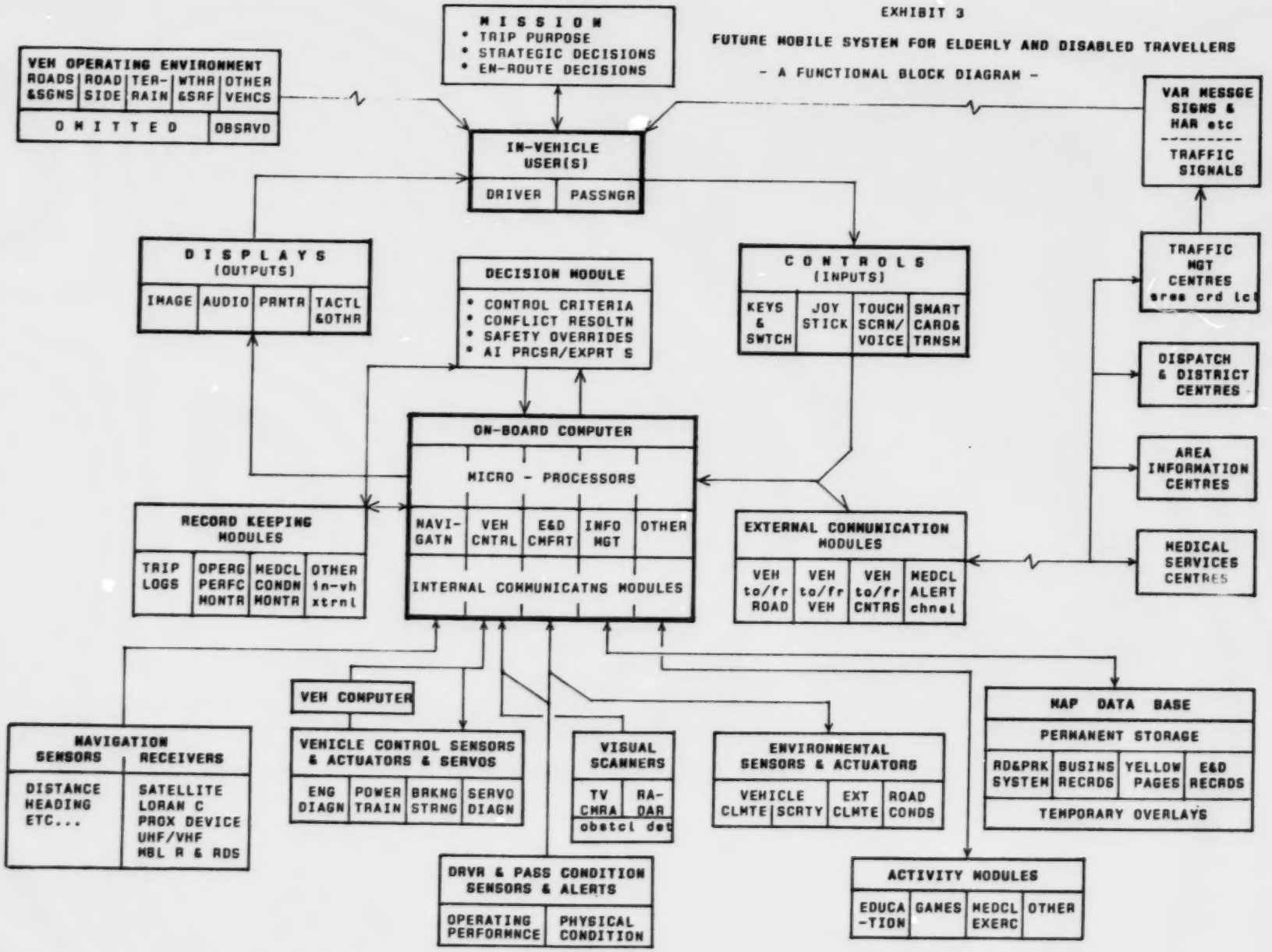
MICRO-ELECTRONICS APPLICATIONS FOR E&D TRAVELLERS
- DEVELOPMENT STATUS & POTENTIAL -

DEVELOPMENT STATUS	POTENTIAL
PERSONAL COMMUNICATIONS DEVICES	
A substantial variety of personal communications devices are fully developed and commercially available. Some of these can be hand-held, attached to a limb, or attached to a mobility aid such as a wheelchair. Such devices include: - speech amplifiers - personal printer/communicator - spoken message retrieval systems - multiple language translators - personal reminder message system	A proliferation of gadgets may not be the best approach. Multi-functional portable devices which are compatible with fixed communication systems in public buildings and terminals would be a significant improvement. Considerable research and development would be needed to achieve this.
PERSONAL MOBILITY AIDS	
A limited number of personal mobility aids and systems have been developed and tested. Some commercial examples include: - obstacle sensors - active tactile systems - pedestrian route tracing systems - special signing	There are almost unlimited opportunities for further development by the commercial sector. Public sector development could focus on interactive systems for public buildings and transportation terminals.

EXHIBIT 3

FUTURE MOBILE SYSTEM FOR ELDERLY AND DISABLED TRAVELLERS

- A FUNCTIONAL BLOCK DIAGRAM -



- a trigger or joy stick control for steering, acceleration and braking; a variable power-assist unit for easier steering in parking and in turns
- key-board, touch pad/touch screen, or speaker-dependent voice-driven controls - which incorporate personalized voice templates - for the vehicle operation (including visual scanners) and for other functions (on-board data base and communication management, games, etc)
- controls for activating and specifying driver and passenger condition monitoring systems, and for activating environmental systems.

The input device will also provide for controlling standard mobile information system functions. It will allow entry of interim and final destinations for trips, setting criteria for requested route guidance (e.g. minimum number of left turns, scenic route) and for operating the communication system. Most controls will need to allow support of both drivers and passengers, and will benefit both disabled and elderly users.

4.2.2 Displays (Outputs)

Display units currently in use or under development operate on image (screen or printer), audio, or tactile (vibration, or mild current) channels. They include vector and raster scan type CRTs (cathode ray tubes) typically used to display map information - both of which can be colour or monochromatic. Simplified display panels are of LED (light emitting diode), LCD (liquid crystal display), fluorescent or luminescent type. Some are formatted to show a few lines of variable text, others to show symbolic shapes to indicate expected driving maneuvers.

Advanced HUD units (heads-up displays) project critical parts of the instrument panel - and when required, a general alert signal - onto the windshield (actually to be in focus on top of the hood). These will be particularly useful for drivers who wear bi-focal lenses - although the night-time performance of HUD devices still requires investigation.

For persons with any hearing loss, the in-vehicle environment can be particularly disorienting - and audible systems can only be used as part of a multi-channel display device (as a complement to a visual or tactile display). Their practical use will often be to alert others in the vehicle - who may

then act as intelligent co-drivers for the elderly or disabled driver.

4.2.3 On-Board Computer

At the heart of the mobile information/management/control system is an on-board computer and its applications software. It provides processing (calculations) - both automatic, in response to the system needs, and based on commands received from the input device and/or via external transmissions - for all system functions:

- vehicle position, navigation and route guidance
- vehicle operating assistance and control
- occupant comfort, security and entertainment; and vehicle and cargo security
- information (data base) and communications management.

Many of the most safety-critical system functions are designed to enhance the driver's ability to observe and actually account for an adequate portion of the full vehicle operating environment - and his/ her limitations to safely operate in various traffic conditions and in both familiar and unfamiliar areas.

Decision Module: The decision module - which contains the primary system control criteria, such as display options, maximum governed speeds, etc - may need to be modified for elderly and disabled drivers. For example, it could be desirable to screen out all information from the display unit that is not essential to the type of trip being made - or possibly display no information, except for indicating suggested turns or speeds, while the vehicle is in motion.

If a particular driver was restricted by license from driving at night or on specific highway categories (as can be required in British Columbia, for example), the unit would alert the driver accordingly or route him/her off the restricted highways. Safety overrides could also be used to direct a driver to a safe stopping place and await further instructions when safety protocols have been breached.

In the case of advanced intelligent systems, the AI Processor (Expert System) could be designed to learn from the driving/ operating performance of each user and make adjustments

accordingly. For example, the system could - based on accumulated data from various driving conditions (e.g. at different traffic congestion levels) - adjust the original buffers, e.g. increase the advisory clearance interval between the vehicle, driven by an elderly or disabled person, and any vehicle just in front of it - in order to eliminate the need for abrupt braking and steering maneuvers. The AI Processor would increase these buffers over time, almost imperceptibly, while also increasing the number of operating advisories (driving instructions) provided - until the problem, of following too close, has been resolved.

The Expert System would also evaluate the records kept on advisories received from the central traffic control, and adjust route recommendations accordingly. That is, on a frequently travelled route, the wisdom of blindly following an externally transmitted congestion-related route recommendation would be assessed - and, at times, the received advisories would be rejected or adjusted (at the option of the user, before being displayed).

Record Keeping Modules: These modules accumulate basic trip logs - including accumulative travel distances by trip purpose, if requested by user - and fuel consumption/emissions information. The records would probably also include statistics on operator performance (speeds used, % driven over speed limits, abrupt handling, etc) and on traffic conditions (by metropolitan corridor, weekday, and time of day).

The records can be used to assist E&D drivers (e.g. to develop automated routing systems), as well as for fleet management, including driver training and retraining programs. In the case of seniors and drivers with disabilities, decision monitoring could identify problems such as driver fatigue due to multitasking, for example. A trip log would identify the preferred routing which could be analyzed for safety hazards, e.g. frequency of left turn movements. Smartcard based recording of travel events, such as the above statistics and data from the health monitoring sensors, could also be incorporated - for a later display to the driver's doctor (or the mechanic, in the case of vehicle data).

4.2.4 Navigation Sensors and Receivers

The primary sensors in a self-contained autonomous navigation system are for distance (e.g. non-contact electronic odometer) and heading (e.g. magnetic compass or gyroscope plus differential odometer). Their values are used, together with corrective map-matching techniques, to provide the vehicle's position (against a map data base). General purpose systems also incorporate external signals for location determination - from sources such as GPS, Loran-C or a proximity device (e.g. road-side beacon, AVI/AVL/AVM interrogator unit).

Autonomous route advisory systems allow the entry of destination(s) - and, based on the vehicle's position at any given time, offer driving directions, including remaining distance and heading to the desired destination. The route guidance systems can also be infrastructure-assisted, dynamic or inter-active. In the case of E&D, the guidance provided by the central traffic control probably ought to be 'individual', as opposed to 'collective' - i.e. optimized to guide the E&D traveller based on his/her pre-selected criteria, rather than designed to maximize the benefits for the overall system.

4.2.5 Vehicle Control Sensors, Actuators and Servos

Many adapted vehicles operated by drivers with disabilities require - in addition to hand controls for the accelerator and brake functions - servo actuators for braking and steering. Vehicle diagnostic systems may be required to alert seniors and drivers with disabilities of impending problems. An example of this would be a system that could detect a loss of tire pressure and alert the driver to leave the traffic stream or freeway. The map data base would then be engaged by the route module to guide the vehicle to a garage - a CAA member garage, if available near-by.

Visual Scanners: Scanning systems need to be able to detect clearances in the front, rear, and sides, and even on top of the vehicle (i.e. to observe clearances between a van roof and garage doors). Some types of scanners, such as infrared, may be better for long range warning systems while others, using ultrasonic sound waves or video systems, will be useful for detecting obstacles when backing up or parking. Such an obstacle detection system could be particularly help-

ful to drivers needing to release a wheelchair ramp or gain access to a side entrance from a wheelchair. Advanced systems will incorporate a forward-looking radar with cruise control for an 'intelligent cruise', or collision avoidance system.

Night vision enhancement radars can provide additional help to those who otherwise are already capable of night driving. In general, the scanners can help compensate for at least part of lost vision - e.g. reduce the 30% for a person who is otherwise rated at 70%. Future systems will be able to 'read' lane markings and tell the driver when he/she begins to stray. In night driving, these systems can be assisted by head lamps that emit both regular, visible light (as the low beam) and ultra-violet rays (as the only high beam) - as this significantly reduces glare from other vehicles. Since this will require that road signs be coated with materials that reflect the rays and convert them to visible light, such head lamps will not be available in the foreseeable future.

4.2.6 Occupant Condition and Environmental Sensors and Actuators

These sensors typically monitor the performance of the driver in each of the driving tasks (e.g. abruptness of braking and steering corrections, snooze alert). They may also, through medical sensor hook-ups, monitor the physical condition of the driver and/or passenger(s). The operating performance information in future systems will likely be coordinated with readings from the environmental sensors - weather conditions (visibility) and road conditions (surface slipperiness).

The Expert System will then provide advisories based on either start-up values (control values and various buffers introduced by the installer) or based on its own (system-developed) values. In winter driving conditions the environmental data is passed on to the route module, which will then attempt to guide - to the extent practical - the vehicle along well-travelled (clear & dry) routes to its destination. Under severe conditions, the system may recommend discontinuing the trip - returning to base or finding an interim destination.

4.2.7 Activity Modules

For the purposes of education and entertainment, future systems will likely incorporate many features which will make travel more productive, informative and enjoyable. Software will be designed to display information, from both the data base and the area and road-side transmitters, based on personalized preferences (display masks) - with a tie-up to the vehicle's location.

Games, language learning modules, etc may be incorporated. For elderly and disabled travellers, mental and physical exercise modules (that offer suggestions on rest stop frequencies) may be provided. A module may be included to make reading possible for passengers with limited vision; this may require that the display unit can be moved and reconnected at another position within the vehicle (not just at the driver console or dash).

4.2.8 Map Data Base

Many modern systems contain an extensive digitized data base, or an G.I.S. (geographic information system), of road map and other information stored on a cassette or a CD-ROM. Since the latter permanent storage unit can only be read by the in-vehicle device, there is a requirement for a method to obtain and retain temporary overlays.

These can provide updates on accessible and specialized facilities, e.g. hospitals, treatment centres (Ref: 53); transportation terminals (Ref: 51); motels and camping sites (with special E&D rates), recreational facilities and play grounds (Ref: 'Access America'). They may also contain special E&D needs and criteria, and temporarily store update transmissions from traffic control and medical services centres. The built-in software will then incorporate information from these overlays to the internal decision processes and any map displays or auditory advisories.

4.2.9 External Communication Modules

Except for totally autonomous navigation systems, future comprehensive systems will include - in addition to communication functions within the vehicle itself (between the naviga-

tion/information/communication/E&D assistance unit and the vehicle's own computer) - modules for communicating between:

- the vehicle and road-side interrogator and transmitter units (including parking meters and access gates)
- vehicles in the traffic stream
- the vehicle and various traffic management, fleet control, and other communication centres.

The technologies will range from the conventional citizens' band (CB) and HAM radios, short-wave radios and cellular telephones, to advanced close-range interrogator units (communicating through each vehicle's AVI tag with its on-board computer and display unit), road-side beacons, radio data systems (RDS), digital audio broadcasting (DAB), and satellite transmissions.

Drivers and passengers with certain medical conditions may require direct, priority channel two-way communication with an external Medical Services Centre (MSC) both for monitoring purposes and to summon assistance in an emergency. Computers at MSC may be assigned to store and track the planned route of each critical vehicle. A medical alert module to monitor the driver and/or passenger condition (blood pressure, pulse, ...) has been included.

External communication capability can be critical in ordinary circumstances as well, such as in the case of a stalled vehicle. But there will also need to be some very ordinary back up 'systems': a send help/call police sign, thermo-blanket, a heat source, extra medication, and high energy food.

5. RECOMMENDATIONS

To advance the development, testing and demonstration, and deployment of micro-electronic technologies to assist elderly and disabled travellers, the undertaking of a major R&D program should be considered. There are four primary reasons for accelerating these intelligent vehicle-highway systems (IVHS) developments and applications:

* the number of elderly and disabled persons is increasing and will continue to do so
* mobility of current elderly and disabled persons requires significant improvement

* the emerging technology will provide opportunities for increasing the productivity and efficiency of the surface transportation sector in general
* all in-vehicle modules and integrated systems designed to respond to the special needs of elderly users will, in the end, be easier and safer to learn and use to all travellers.

The last point is important - because, if taken into consideration during the R&D phase, it will result in lower cost devices than would be the case if only elderly were the target market. Although further work is required to clearly specify all the areas for IVHS R&D in support of elderly and disabled travellers[2], preliminary skeleton outlines for four priority projects are provided in the following:

- HUMAN FACTORS/ERGONOMICS ASSESSMENT
  - undertake, with a special focus on elderly and disabled travellers, a preliminary human factors/ergonomics assessment of the primary five in-vehicle devices currently available on the market or in advanced development stage (in actual testing)
  - undertake a brief literature review of existing human factors work on advanced in-vehicle systems (that offer traveller information, mobile office, driver and passenger comfort/security/monitoring, and/or vehicle control features)
  - assess man-machine-interface (MMI) design vis-a-vis typical E&D users with representative physical and other constraints
  - assess the ease of learning of available functions, and the overall effort required to use the input module(s) and interpret display(s)
  - investigate the possibility of using a driving simulator (Ref: 84) to assist in these research tasks
  - assess safety of use in demanding situations, i.e. when the vehicle is in motion in an unfamiliar area with poor visibility and other hindrances (i.e. impact of system control efforts for navigation and other key functions on the primary driving tasks)
  - assess differences between individual devices/functions vs integrated functions and intelligence provided by an expert system
  - identify problems in current/planned systems; develop an improved human factors concept design and an in-vehicle mock-up unit

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2] Including a detailed review of the development and integration requirements for those applications described in Appendices B-1 to B-14 [of this report], which have not been incorporated in the four priority projects.

- develop preliminary design, installation and usage guidelines.

□ ADVANCED TRAVELLER INFORMATION SYSTEM FOR ELDERLY AND DISABLED TRAVELLERS (ATIS/E&D)

- develop a concept design for a Canadian ATIS unit with autonomous vehicle location display and route guidance capability plus special functions to provide other value-added features for elderly and disabled drivers and passengers
- many of the possible functions are included in Appendix A/Sections 1-2 and 5 (and some within 3), and in B.2 (accessible entrance locator), B.11 (trip planning data base), and B.13 (driver information system organizer)
- test two different mock-up units (which may incorporate components from currently available systems), several function sets, and the use of individually definable 'masks' in controlled laboratory conditions
- develop an expert system concept which will record and then learn from trip making patterns and driving performance in order to adjust internal buffers and advisories accordingly
- assemble roughly 20 demonstration units for installation in private and rental fleet cars and vans (some that are equipped with hand controls, some without)
- incorporate sensors in steering and brake/accelerator mechanisms to monitor and record abrupt handling while the device controls are being used
- demonstrate the use of the units, and refine critical hardware and software elements towards a production design.

□ ADVANCED VEHICLE CONTROL SYSTEM FOR E&D (AVCS/E&D)

- design a Canadian AVCS, to assist elderly and disabled drivers, which combines access/comfort/security features with advanced vehicle control/driver-assist systems
- possible functions include: variable effort power steering (App B.1), enhanced night vision (App B.9), driver monitoring and denial (App B.14); and advanced cruise control, rear/side/top warning, etc (App A/Sections 4, 6-7, and some within 3)
- proceed as in the ATIS/E&D project above
- note: both development activities should proceed on a modular design approach which will allow the possible future integration of the two systems.

□ INVESTIGATION OF E&D TRAVELLER DECISION MAKING

- investigate E&D traveller decision making for urban, metropolitan and intercity car and van trips (ref: the 'Mission' box of Exhibit 3), focusing on:

    - decisions on travel mode; selections for travel days, departure and/or expected arrival times, facility (facility type, expected/known congestion levels), routing (left/right turns, ...), etc
    - travel aids (pre-trip, en-route) and their use by trip type (particularly frequency of using intelligent co-driver)
    - en-route decisions: the effect of observed/omitted environmental factors (ref: the 'Vehicle Operating Environment' box of Exhibit 3)
- apply an innovative mix of methodologies: literature review, survey, site observations, interviews and focus groups, and computer simulation
- preliminary simulation method: record decision making when subjects exposed to route guidance and partial other information (visible on CRT) about traffic and road conditions on alternative routes ahead.

Some elements of the system integration, demonstration and customization phases of the above projects could be considered for funding within the airport and technology transfer initiatives of the current *National Strategy for the Integration of Persons with Disabilities* (accessible taxis and rental vehicles). Other resources must be sought to properly accommodate early research and development phases of the same and other priority projects.

IVHS/RTI applications can make a significant contribution to improving the mobility, choice, comfort and security of elderly and disabled travellers. But it is essential that their needs be recognized now, early in the development of in-vehicle devices - and not just as an afterthought, which would surely result in cumbersome, user-unfriendly retrofits. It is also clear that the recognition of E&D requirements will significantly enhance the marketability of the devices to users-at-large.

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   #. REPORT TITLE (in caps)
      Author'sLastName FirstInitial SecondInitial/HisOrHerFirm; Sub-Agency/Agency ForWhomReportDone; ReportNumber, Month Year.

SOURCE AGENCIES: Agencies are Ontario ministries unless otherwise stated; authors are from those ministries unless otherwise stated.

APPENDIX A

PRELIMINARY LIST
OF
FUNCTIONS AND FEATURES

1. TRAVEL ADVISORY / NAVIGATION SYSTEMS
2. SPECIALIZED TRANSPORTATION ADVISORY
3. VEHICLE MONITORING/SAFETY/PERFORMANCE
4. VEHICLE CONTROL
5. DRIVER MONITORING/ASSIST
6. PRIMARY DRIVING CONTROLS
7. SECONDARY DRIVING CONTROLS

APPENDIX A

PRELIMINARY LIST OF FUNCTIONS AND FEATURES

1. TRAVEL ADVISORY / NAVIGATION SYSTEMS

* road map display (skeleton, interim and full formats depending whether the vehicle is in motion)
  - in-vehicle CRT
* traffic rules
  - reception of allowable times & charges from road-side parking beacons
  - advance reception about turn restrictions
  - etc...
* parking privileges
  - on-board transponder (to transmit permit to a parking privilege interrogator unit)
  - top-of-the-dash display of permit (when display requested by driver)
* site guidance for access ramps, service areas, tourist attractions, etc
* route guidance using simplified aural/visual turn instructions (pre-set and/or system-calibrated to transmit optimum distance prior to turns depending on facility/turn type and traffic conditions, and to be repeated required number of times prior to critical-point transmission)
  - best route: most scenic, least stressful, easiest to steer, ...
* electronic transponders and interrogators for toll booth operation
  - automatic billing to credit card agencies
  - automatic debiting off pre-purchased toll privilege cards (on-board)
* electronic billboards
  - weather and road surface conditions
  - information on traffic conditions (incl. reasons for and expected duration of delay)
  - event information
* road side and community services information
* trip planning (advance scanning of routes and optimum travel hours based on O&D and other inputs; intermodal connections; ...)
* weather and road surface updates (affecting visibility, steering, stopping distance, smoothness/roughness of travel)
* electronic notepad (voice activated)
* ...

2. SPECIALIZED TRANSPORTATION ADVISORY

* directories (on CD-ROM & EEPROM, beacon up-dates, and on-line interactive)
  - accessible accommodation
    - hotels, motels, inns, B&B
  - accessible public transportation
    - bus, subway, light rail, taxi, train, ferry
    - paratransit services
    - booking requirements, costs
  - rental agencies for specially equipped personal vehicles, ie:
    - cars
    - vans
    - accessible motor homes
  - rental agencies for wheelchairs, powered scooters, commode chairs
  - wheelchair repair services (24 h service)
  - specialized vehicle repair/replacement services
  - accessible tourist attractions
    - zoos, museums, galleries, ...
  - listing of agencies providing personal care services for travellers
  - gas stations
  - washrooms
* travel guides to Canadian and U.S. cities
  - 24 hour drugstores
  - therapeutic (medical) supplies
  - hospitals & clinics
  - reduced rates for senior citizens
  - ...
* ...

3. VEHICLE MONITORING / SAFETY / PERFORMANCE

* vehicle system status and failure alerts
* en-route tinkering/maintenance tips via aural and/or visual (CRT or printer) displays
* anti-theft and entry restrictions
* fast-alert system: in-vehicle transmitter to broadcast distress signals to emergency services in the event of an accident or other emergency (include distress code & location coordinates if available from vehicle's own navigation unit; alternatively, vehicle beacon signal to be triangulated by monitoring stations)
* call system to outside vehicle
* seat belt assist device: partial automation to help in reaching and adjusting belts (fully automated belts often hinder entry and exit)
* electrochromatic rear-view mirror for those unable to adjust mirrors for night driving
* temperature sensors for closed loop control air conditioning
* electrically heating/tinting windshield and rear window for ice removal in winter, keeping cool in summer (change from light to dark, or clear to translucent)
* moisture sensors in windshield to automatically trigger wipers and spray units
* tire pressure sensors
* heads-up display that projects primary instrument readings and driver alerts (to avoid need to glance down)
* photo cells incorporated into automotive glazing, such as sun roofs, to use solar energy for power (fans to move air inside vehicle, etc)
* headlight washers actuated on starting ignition to clear lights for better illumination
* ...

4. VEHICLE CONTROL

* collision avoidance systems
  - general gap and other warnings (advisory only)
  - automatic braking, to compensate for delayed recognition, errors in decision, or delay in reaction
    (has potential to avoid, at least reduce the severity of a collision)
* advanced (intelligent) cruise control
  - automatically maintains safe distance from vehicle ahead, or enables some vehicles to travel in convoy on a highway
* rear warning system to prevent collisions due to careless lane changing
  - warning light built into outside mirror alerts driver when another vehicle enters blind spot
* close maneuvering warning system
  - rear bumper alert when backing up close to object
  - roof alert when entering shallow spaces (eg. van into parking garage)
* lane positioning: computer linked to cameras (or other sensors) will take control of vehicle should it start to stray across specially demarcated lane boundaries (road centre or edge line)
* ...

5. DRIVER MONITORING/ASSIST

* fatigue monitoring function (recognizing abnormal steering patterns)
* EEG health monitoring through sensors in steering wheel for body temperature, heart rate, etc.
* driver memory: tracking of pre-planned tasks in sequence (process of trip chaining & destination addresses and lay-outs)
* voice systems to warn of dangerous/demanding intersections
* dashboard displays of sharp corners with recommended speed readout (preset or expert system calibrated to match individual's driving abilities)
* voice input (voice recognition system) for vehicle accessories
* night vision system
  - infrared camera to enable driver to see the landscape in front of the car clearly when visibility is low (night, heavy fog)
* road light control systems
  - light emitting devices, embedded in road surface or on roadside, light up ahead of moving car
  - illuminated strips running ahead of a moving car gives advance warning of cars approaching from narrow side roads, or curves

6. PRIMARY DRIVING CONTROLS

* Ignition controls
  - remote start (radio transmitter starts vehicle within 30 m whether one is indoors or out)
  - measures engine conditions and automatically selects the proper starting procedure for a cold or warm engine
  - will automatically restart if the engine stalls
  - activates all pre-set accessories such as heater, air-conditioner, radio, etc
* steering controls
  - self-adjusting length for a steering column, which can also shift from right to left in a van (based on smart card and input unit signal)
  - variable pitch steering wheel (ie. to horizontal) (based on smart card and input unit signal)
  - variable steering: standard power, low effort steering or zero effort steering, all with emergency back-up systems
  - joystick steering - can incorporate steering/braking/acceleration all in one, or separate these functions
  - wireless foot steering systems for individuals with limited use of hands and arms (floor mounted disc affords steering capability with foot)
* acceleration/braking controls
  - adjustable height, pitch of floor pedals for persons of short stature (based on smart card and input unit signal)
  - hand controls - pneumatic, electronic/hydraulic, micro-processor controlled
* ...

7. SECONDARY DRIVING CONTROLS

* keyless entry system (for those who have difficulty inserting keys in general, or in the dark)
  - push button electronic combination lock that operates van doors and wheelchair lift in sequence
  - special features guard against vandalism
* 6-(8) way power seat with memory
  - facilitates driver's self-transfer from a wheelchair to the driver's seat
  - provides 30 cm travel front to rear, 23 cm of height adjustment, and 90 degrees of swivel, (power tilt)
* automatic wheelchair restraint systems
  - dual docking points that latch the wheelchair occupant securely in the driver or passenger position
  - shall be equipped with an audio and/or visual indicator when tiedown system becomes engaged
* remote functions through control centre
  - programmed to control up to 48 driving accessory functions, activated by toggle switches or push button switches, ie:
    - keyless ignition
    - gear shift
    - emergency brake
    - steering up/down
    - blower switch
    - remote mirrors
    - powered headrest
    - windows/door locks
    - turn signals
    - head lights
    - cruise control
    - horn
    - dimmer switch
    - wiper/washer
    - rear alert
    - ...
  - may have dash mounted display panel for visual clues of each function
* ...

APPENDIX B

MICRO-ELECTRONICS APPLICATIONS

1 VARIABLE EFFORT POWER STEERING

2 ACCESSIBLE ENTRANCE LOCATOR

3 INTERACTIVE TACTILE SYSTEM

4 PERSONAL REMINDER/LOCATOR

5 ENHANCED PUBLIC ADDRESS SYSTEM

6 PERSONAL LOCATOR

7 PERSONAL RIDER INFORMATION SYSTEM

8 PERSONAL VIDEO/AUDIO STATION

9 ENHANCED NIGHT VISION

10 VISUAL SIGNAL AND MESSAGE SYSTEMS

11 TRIP PLANNING DATA BASE

12 PERSONAL TRANSLATOR

13 DRIVER INFORMATION SYSTEM ORGANIZER

14 DRIVER MONITORING AND DENIAL SYSTEM

VARIABLE EFFORT POWER STEERING

Target Market

Drivers with neuro-muscular disabilities, e.g. post polio, muscular dystrophy, muscular atrophy, multiple sclerosis and post stroke.

Population Segment

Seniors and physically disabled drivers (more than 16 000 with adapted vehicles).

Objective

Amplify power steering effort in inverse proportion to vehicle speed.

Scope of Application

(*)	Auto Driver	( )	Trip Planning
( )	Auto Passenger	(*)	Driver Training
(*)	Taxi	( )	System Enquiries
(*)	Paratransit	( )	Reservations
(*)	Urban Bus	( )	System Security
(*)	Intercity Bus	( )	System Performance
( )	Mass Transit		
( )	Terminal Facilities		

Performance Specification

Maximum steering advantage to be achieved at zero speed for parking. Requires monitoring of vehicle speed similar to that of electronic cruise control systems. Pressure amplifier on hydraulic control system actuated by electronic speed monitor with post mounted controls.

Consumer Benefits

(*)	Improved Convenience	(*)	Reduced Fatigue
(*)	Improved Safety	( )	Reduced Stress

Other Benefits

Could become an industry standard for all drivers with less upper body strength.

Development Requirements

Search automotive product development departments.

ACCESSIBLE ENTRANCE LOCATOR

Target Market

Disabled drivers/commercial facilities including parking corporations.

Population Segment

Drivers and passengers who use walking aids (some 750 000 adults).

Objective

Locate the parking space nearest to accessible entrance.

Scope of Application

(*)	Auto Driver	( )	Trip Planning
(*)	Auto Passenger	( )	Driver Training
(*)	Taxi	(*)	System Enquiries
( )	Paratransit	( )	Reservations
( )	Urban Bus	( )	System Security
( )	Intercity Bus	( )	System Performance
( )	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

Provide homing signal to low band of auto radio. Locate reserved parking and closest entrance based on signal strength.

Consumer Benefits

(*)	Improved Convenience	(*)	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

May have pedestrian applications.

Development Requirements

Search for existing technology which can be adapted to the application.

3

INTERACTIVE TACTILE SYSTEM

Target Market

Persons using or requiring clearly identified pathways in transportation terminals.

Population Segment

More than 3 million persons with visual, hearing and mobility impairment, including those using wheelchairs.

Objective

Improve existing pathway systems.

Scope of Application

( )	Auto Driver	( )	Trip Planning
( )	Auto Passenger	( )	Driver Training
( )	Taxi	( )	System Enquiries
( )	Paratransit	( )	Reservations
( )	Urban Bus	(*)	System Security
( )	Intercity Bus	(*)	System Performance
( )	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

Personal device required that emits a very narrow reflected signal from tactile markings. A reflector or reflective material would be imbedded in the tactile markers.

Consumer Benefits

(*)	Improved Convenience	(*)	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

Less costly than an active tactile system, particularly during periods of construction.

Development Requirements

Optional materials that will reflect a transmitted signal need to be tested (existing markings may work in some cases.) There may be a wide range of signal systems possible, including LASER systems and other optical devices.

4

PERSONAL REMINDER/LOCATOR

Target Market

Passengers who may become disoriented in transportation terminals and miss their assigned departure time.

Population Segment

Persons with hearing disabilities, cognitive disabilities and short-term memory (estimated 200 000 persons).

Objective

Provide a pocket-sized clip-on radio receive with a built-in locator.

Scope of Application

( )	Auto Driver	( )	Trip Planning
( )	Auto Passenger	( )	Driver Training
( )	Taxi	( )	System Enquiries
( )	Paratransit	( )	Reservations
( )	Urban Bus	(*)	System Security
(*)	Intercity Bus	(*)	System Performance
( )	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

A low-cost personal message receiver system compatible with operator public address systems is required. A locator homing signal could be included to alert security and customer service attendants.

Consumer Benefits

(*)	Improved Convenience	( )	Reduced Fatigue
(*)	Improved Safety	( )	Reduced Stress

Other Benefits

Improved on-time and load factor performance for carriers.

Development Requirements

An extension or refinement of the capability of personal pager technology may yield the desired product. Options include interaction with wayside stations and/or direction to paging telephones.

ENHANCED PUBLIC ADDRESS SYSTEM

Target Market

Those persons experiencing loss of high and low frequency ends of audio spectrum.

Population Segment

Some 1 000 000 hearing impaired adults.

Objective

Improve audibility of public address system messages.

Scope of Application

( )	Auto Driver	( )	Trip Planning
( )	Auto Passenger	( )	Driver Training
( )	Taxi	( )	System Enquiries
( )	Paratransit	( )	Reservations
(*)	Urban Bus	( )	System Security
(*)	Intercity Bus	(*)	System Performance
(*)	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

Amplify the speech range of public address systems through the use of auxiliary modulation and/or provide personal speech booster devices to clientele.

Consumer Benefits

(*)	Improved Convenience	( )	Reduced Fatigue
( )	Improved Safety	(*)	Reduced Stress

Other Benefits

Improves audibility of public announcements for all passengers.

Development Requirements

A refinement of existing technology used in high fidelity music systems is one possibility. Other technology that should be reviewed includes devices marketed in the U.S.A. known as "Magic Ear" and "Speech Booster".

6

PERSONAL LOCATOR

Target Market

Residents of extended care facilities, nursing homes and individuals being cared for by family members who may lose their sense of direction.

Population Segment

Pedestrians with mental or medical disorders (such as Alzheimer's disease) who may become "missing persons" (estimated 300 000 persons).

Objective

Provide a method of quickly locating lost or confused persons.

Scope of Application

( )	Auto Driver	( )	Trip Planning
(*)	Auto Passenger	( )	Driver Training
(*)	Taxi	( )	System Enquiries
(*)	Paratransit	( )	Reservations
(*)	Urban Bus	(*)	System Security
(*)	Intercity Bus	( )	System Performance
(*)	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

A relatively small unobtrusive device is required that can be worn as part of clothing or personal jewellery for security purposes. The device must emit a localized homing signal in similar fashion to more powerful devices presently installed in aircraft.

Consumer Benefits

( )	Improved Convenience	( )	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

May have other applications in aviation, exploration and the military.

Development Requirements

Further development of the concept of personal locators presented by "Oracle" in the Science Pavilion at Expo '86 in Vancouver.

PERSONAL RIDER INFORMATION SYSTEM

Target Market

Transit riders who may fail to board on the correct bus or get off at the correct bus stop.

Population Segment

Transit riders with medical or mental disorders and visual disabilities (estimated 500 000 persons).

Objective

Provide a bus route/bus stop coded alert system.

Scope of Application

( )	Auto Driver	(*)	Trip Planning
( )	Auto Passenger	( )	Driver Training
( )	Taxi	(*)	System Enquiries
( )	Paratransit	( )	Reservations
(*)	Urban Bus	(*)	System Security
( )	Intercity Bus	(*)	System Performance
(*)	Mass Transit		
( )	Terminal Facilities		

Performance Specification

Provide a personal receiver system that alerts passengers when their particular bus arrives and when their destination bus stop is reached.

Consumer Benefits

(*)	Improved Convenience	( )	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

May enhance and extend the value of installing AVM systems.

Development Requirements

Existing AVM systems such as TeleRIDER, TeleMESSAGE, TeleTRANSPO, for example, may be able to facilitate a mobile message service. Separate systems may also be possible using the bus stop coding systems already in place in several urban areas.

8

PERSONAL VIDEO/AUDIO STATION

Target Market

Urban and inter-city bus passengers.

Population Segment

Persons who have impaired short-term memory or who require message reinforcement and reassurance (estimated 400 000 persons).

Objective

Reduce information load on operators and attendants.

Scope of Application

( )	Auto Driver	( )	Trip Planning
( )	Auto Passenger	( )	Driver Training
( )	Taxi	(*)	System Enquiries
(*)	Paratransit	( )	Reservations
(*)	Urban Bus	( )	System Security
(*)	Intercity Bus	( )	System Performance
( )	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

Basic audio/video system operated from on board the vehicles. Develop special messages for passengers with high levels of anxiety. Pre-record route information.

Consumer Benefits

(*)	Improved Convenience	( )	Reduced Fatigue
( )	Improved Safety	(*)	Reduced Stress

Other Benefits

Less stress on operating staff.

Development Requirements

Develop a portable version of existing personal video screens attached to seating in terminal facilities for use on board vehicles. Program to be operated from pre-recorded message video on board similar to system used by airlines.

ENHANCED NIGHT VISION

Target Market

Drivers whose visual acuity is diminished under conditions of low light, e.g. at night, by fog, in rainy weather, etc.

Population Segment

Some 250 000 persons with visual acuity below standard levels.

Objective

Enhance level of acuity.

Scope of Application

(*)	Auto Driver	( )	Trip Planning
( )	Auto Passenger	(*)	Driver Training
(*)	Taxi	( )	System Enquiries
(*)	Paratransit	( )	Reservations
(*)	Urban Bus	(*)	System Security
(*)	Intercity Bus	(*)	System Performance
( )	Mass Transit		
( )	Terminal Facilities		

Performance Specification

Develop individual optical enhancement device or windshield-mounted device enhancing infrared spectrum (note Polaroid technology).

Consumer Benefits

( )	Improved Convenience	(*)	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

Mass production could substantially reduce cost for industrial and military operations.

Development Requirements

Examine military systems for potential mass application.

10

VISUAL SIGNAL AND MESSAGE SYSTEMS

Target Market

Persons who experience difficulty with the use of telephones and therefore require a visual display of transmitted information.

Population Segment

Some 58% of persons with impaired hearing (565 000 adults).

Objective

Display visual signals and messages via telephone systems.

Scope of Application

( )	Auto Driver	( )	Trip Planning
( )	Auto Passenger	( )	Driver Training
( )	Taxi	(*)	System Enquiries
( )	Paratransit	(*)	Reservations
( )	Urban Bus	(*)	System Security
( )	Intercity Bus	( )	System Performance
( )	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

Install information systems and screens in terminals. Develop standard telephone attachments and plug-ins for personal phones. Utilize message lights for alarm systems. Install tactile vibrators where necessary.

Consumer Benefits

(*)	Improved Convenience	(*)	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

Less stress on operating and terminal staff.

Development Requirements

Develop standards for technology. Review telephone R&D in progress.

TRIP PLANNING DATA BASE

Target Market

All persons requiring advance planning of urban and inter-city travel because of physical, mental or medical considerations.

Population Segment

(At least 2 million persons.)

Objective

Reduce uncertainty in multi-modal travel decision making.

Scope of Application

( )	Auto Driver	(*)	Trip Planning
( )	Auto Passenger	( )	Driver Training
(*)	Taxi	( )	System Enquiries
(*)	Paratransit	( )	Reservations
(*)	Urban Bus	( )	System Security
(*)	Intercity Bus	( )	System Performance
(*)	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

Develop data base of actual travel scenarios for public access - similar to Oracle Communications files for Expo '86. Identify all transfer requirements and processes and all accessible facilities en-route.

Consumer Benefits

(*)	Improved Convenience	( )	Reduced Fatigue
( )	Improved Safety	( )	Reduced Stress

Other Benefits

Based on wide usage by travellers, companions, travel counsellors and others, system could be self-supporting.

Development Requirements

Accumulate data base for pilot project using typical trips by persons with disabilities (a possible project for INDEPENDENCE 92 in Vancouver.) File experience by origins and destinations. Field test trips. Program automated telephone information system. Provide for hard copy upon request.

12

PERSONAL TRANSLATOR

Target Market

Persons who experience difficulty making themselves understood by speech.

Population Segment

About 243 000 adults with speech impairments.

Objective

Provide visual messages from transportation system operators and travel agencies.

Scope of Application

( )	Auto Driver	( )	Trip Planning
( )	Auto Passenger	( )	Driver Training
(*)	Taxi	(*)	System Enquiries
(*)	Paratransit	(*)	Reservations
(*)	Urban Bus	( )	System Security
(*)	Intercity Bus	(*)	System Performance
( )	Mass Transit		
(*)	Terminal Facilities		

Performance Specification

This pocket version of "Transaid" requires a hand-held micro computer with the capability of displaying standard travel inquiries. Responses can be accommodated by fixed units at information counters or verbal. Personal unit must be able to confirm that answer is understood.

Consumer Benefits

(*)	Improved Convenience	( )	Reduced Fatigue
( )	Improved Safety	(*)	Reduced Stress

Other Benefits

Could have "other language" as well as French or English applications.

Development Requirements

Review capability of existing technology used for instant translation of foreign phrases. Develop standard phrases for transport enquiries.

DRIVER INFORMATION SYSTEM ORGANIZER

Target Market

Drivers having difficulty with information overload.

Population Segment

Older drivers and those with disabilities (not less than 2 000 000 persons).

Objective

Present information audibly in a logical sequence and hierarchy for decision making. Reduce "noise" in the system.

Scope of Application

(*)	Auto Driver	( )	Trip Planning
( )	Auto Passenger	(*)	Driver Training
(*)	Taxi	( )	System Enquiries
( )	Paratransit	( )	Reservations
(*)	Urban Bus	( )	System Security
( )	Intercity Bus	( )	System Performance
( )	Mass Transit		
( )	Terminal Facilities		

Performance Specification

Requires integration of vehicle diagnostic systems with external monitoring and routing systems. Audible guidance (when required) should be by synthetic voice.

Consumer Benefits

(*)	Improved Convenience	(*)	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

Could become an industry standard for IVHS applications.

Development Requirements

Many components already available. Requires a pilot demonstration program to develop and integrate components. Programming must include safety over-rides in case of mechanical failure, eg. "increase your clearance on the curb side" could be over-ridden to "slow down, look for a safe stopping place, and come to a full stop - your right rear tire is going flat!"

14

DRIVER MONITORING AND DENIAL SYSTEM

Target Market

Drivers with disabilities or medical conditions which can reduce their ability to drive or become life threatening.

Population Segment

Drivers and passengers with heart conditions, subject to seizures or with disabilities which may result in a medical emergency.

Objective

Summon medical assistance and/or deny impaired driver the operating of the vehicle.

Scope of Application

(*)	Auto Driver	( )	Trip Planning
(*)	Auto Passenger	( )	Driver Training
( )	Taxi	( )	System Enquiries
(*)	Peratransit	( )	Reservations
( )	Urban Bus	( )	System Security
( )	Intercity Bus	( )	System Performance
( )	Mass Transit		
( )	Terminal Facilities		

Performance Specification

In-vehicle system must continuously monitor driver - and, in an emergency, communicate with a central security facility. System must deny entry to unfit drivers.

Consumer Benefits

( )	Improved Convenience	( )	Reduced Fatigue
(*)	Improved Safety	(*)	Reduced Stress

Other Benefits

Improved safety for other users of the road system.

Development Requirements

Review existing monitoring technology and motor company research on in-vehicle breathalyser analysis and security systems. Develop code sequences, from which driver must key in a randomly selected one at time of entry to test cognitive ability (transmitted to him/her, at option, by visual or aural means). Develop safe shut-down systems in case of medical emergency.

APPENDIX C

REPRESENTATIVE SYSTEMS
PRESENTED FOR ILLUSTRATIVE PURPOSES ONLY
(NO SYSTEM SELECTIONS OR PREFERENCES IMFLIED)

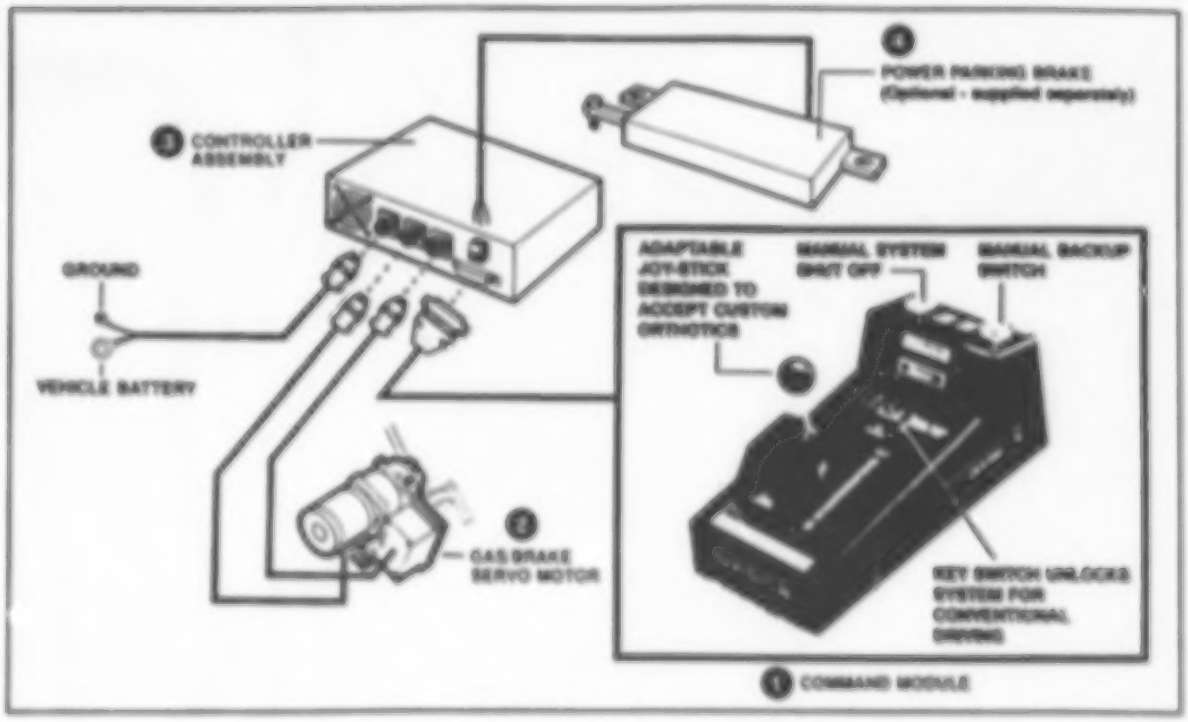
C.1 ELECTRONIC GAS/BRAKE AND EVALUATOR ELECTRONIC CONSOLE

C.2 TRAVTEK IN-VEHICLE UNIT

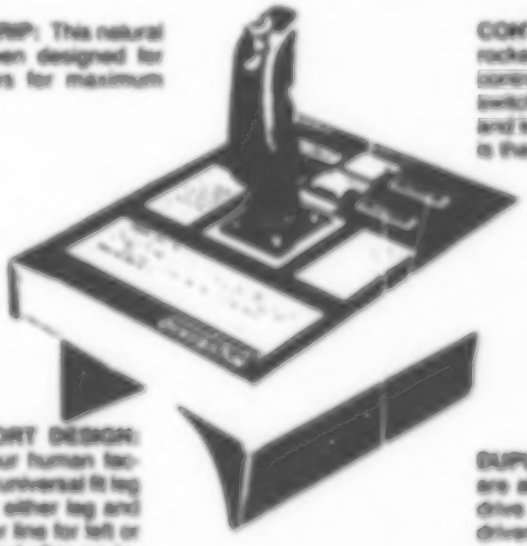
C.3 COLLISION WARNING AND ADAPTIVE CRUISE CONTROL - A CONCEPT DIAGRAM

APPENDIX C.1

ELECTRONIC GAS/BRAKE



EVALUATOR ELECTRONIC CONSOLE



JOYSTICK PISTOL GRIP: This natural feeling shape has been designed for your hand and allows for maximum comfort and control.

CONTROL SWITCH: Conveniently placed rocker switch allows you to gain complete control of the vehicle immediately. Flip the switch toward the driver for driver control and toward the trainer for trainer control. It is that simple!

EVALUATOR COMFORT DESIGN: Engineered around your human factors, this console has a universal fit leg rest. Will sit snugly on either leg and controls are on a center line for left or right hand use. Designed after equipment commonly used in aircraft data equipment.

DUPLICATE DIGIDRIVE STATUS: You are able to monitor the status of all Digidrive driving functions as easily as the driver.

Source: Division Driving Systems, Inc.

APPENDIX C.2

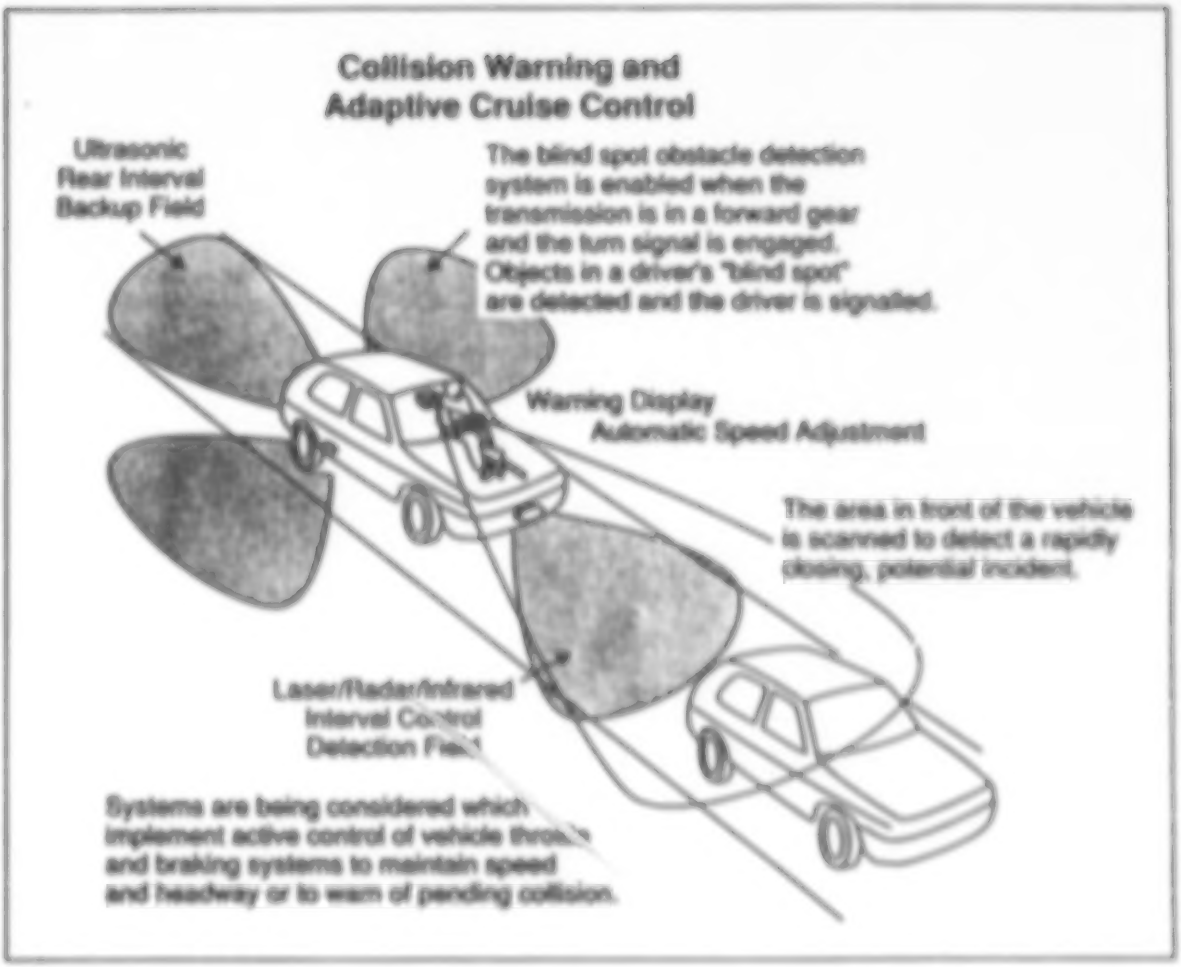
TRAVTEK

IN-VEHICLE UNIT

Source: American Automobile Association

APPENDIX C.3

COLLISION WARNING AND ADAPTIVE CRUISE CONTROL
- A CONCEPT DIAGRAM -


Collision Warning and
Adaptive Cruise Control
Ultrasonic
Rear Interval
Backup Field
The blind spot obstacle detection system is enabled when the transmission is in a forward gear and the turn signal is engaged. Objects in a driver's "blind spot" are detected and the driver is signaled.
Warning Display
Automatic Speed Adjustment
The area in front of the vehicle is scanned to detect a rapidly closing, potential incident.
Laser/Radar/Infrared
Interval Control
Detection Field
Systems are being considered which implement active control of vehicle throttle and braking systems to maintain speed and headway or to warn of pending collision.

Source: SYLLABUS - The Michigan-Based Program in IVHS